Fishery Data Series No. 05-45

Age, Sex, and Length Composition of Chinook Salmon from the 2004 Kuskokwim River Subsistence Fishery

Final Report for Project 04-353
USFWS Office of Subsistence Management
Fisheries Information Services Division

by

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Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

Age, sex, and length (ASL) data were collected from Chinook salmon *Oncorhynchus tshawytscha* harvested during the 2004 Kuskokwim River subsistence fishery to characterize the composition of the harvest from the lower river reporting area. Twenty-one subsistence fishers, from 4 lower river communities, collected the samples. A total of 2,290 Chinook salmon were sampled and ages were determined for 1,979 (86%). Samples were collected from fish caught with a variety of gillnet mesh sizes, but most Chinook salmon (91%) were caught in gillnets with a mesh size ≥ 8 inches (i.e., large mesh gear). The lower river harvest accounts for 86% of the total river harvest and the age composition from lower river sampling was applied to the total river harvest. In 2004 the subsistence harvest is estimated to be 32.5% female and 46.5% age-1.4, 36.5% age-1.3, 13.9% age-1.2 and 2.6% age-1.5 Chinook salmon.

Differences in the age composition of Chinook salmon estimated from the subsistence harvest, commercial harvest, and tributary escapements were attributed to gillnet size selectivity. Fewer young and more older Chinook salmon were harvested in the subsistence fishery using mesh sizes ≥ 8 inches. Age-1.2 male Chinook salmon accounted for 13.8% of the subsistence harvest, 34.5% at the escapement projects, and 57.8% from the commercial harvest from District W-1 where mesh size is restricted to ≤ 6 inches. Older Chinook salmon (age 1.4 and 1.5) accounted for 48.7% of the subsistence harvest, 31.8% at tributary escapement projects, and 15.2% from the commercial harvest. Female Chinook salmon comprised 32.5% of the subsistence harvest, which was considerably higher than the 11.6% female average from District W-1 commercial harvest, and 25.4% female average from escapement projects.

Sampling of the 2004 subsistence Chinook salmon harvest for ASL composition was limited to the lower Kuskokwim River, unlike previous years where middle and upper river samples were collected. Data collected in 2004 continues the baseline begun in 2002 to assess changes in the ASL composition in response to the subsistence fishing schedule, which was instituted as a management tool in 2001 after Kuskokwim River Chinook salmon were identified as a stock of concern by the Alaska Board of Fisheries.

Key words: age, sex, length, ASL, Chinook salmon, king salmon, *Oncorhynchus tshawytscha,* Kuskokwim River, subsistence fishery, age class composition, sex composition, length composition, gillnet, mesh size selectivity, subsistence fishing schedule.

INTRODUCTION

The Kuskokwim River subsistence salmon fishery occurs from the mouth, to the headwaters of the north fork at river mile (rm) 1,548 and is one of the largest subsistence fisheries in Alaska. In 2004 80,065 Chinook salmon *Oncorhynchus tshawytscha*, 52,374 chum salmon *O. keta*, 32,433 sockeye salmon *O. nerka*, and 35,535 coho salmon *O. kisutch* were harvested (T. Krauthoefer, Division of Subsistence, ADF&G, Bethel; personal communication). These harvest numbers are inclusive of the villages of Kipnuk, Kwigillingok and Kongiganak of north Kuskokwim Bay. The annual subsistence harvest of Chinook salmon typically exceeds that of the annual incidental commercial harvest, which averaged 8,775 fish from 1994 through 2003 (Whitmore et al. *In prep*). Subsistence caught Chinook salmon are of particular interest to fishery managers because of the number of fish harvested, the importance of the species as a subsistence food, and because of the implications of subsistence fishers tendency to prefer harvesting Chinook salmon with gillnets of 8-inch or larger mesh sizes (DuBois and Molyneaux 2000). This preferred mesh size range is selective toward catching larger, older fish, and catches a higher percentage of females than caught with smaller mesh nets (ADF&G 1981; DuBois and Molyneaux 2000; Molyneaux et al. 2004a; b). The result is a decrease in the percentage of older aged fish and females as each segment of the Chinook salmon run progresses upstream through the gauntlet of nets towards the spawning grounds. Chinook salmon spawning escapement is, by default, left to those fish that escape the gauntlet of subsistence and commercial gillnets. Hypothetically, the escapement age, sex, and length (ASL) composition should favor that fraction of the adult Chinook salmon population not selected for by gillnets.

For the purpose of this report, all discussion of harvest is limited to that harvest which occurs within the Kuskokwim River. An unknown number of Kuskokwim River Chinook salmon are likely harvested in fisheries that occur in marine waters (Crane et al. 1996). The abundance, stock composition, or final age-of return of these intercepted salmon are largely unknown.

Most Chinook salmon subsistence harvest occurs with gillnets (Ward et al. 2003). Drift gillnets are overwhelmingly the most common contemporary gear type used (Coffing *Unpublished*; Ward et al. 2003). Regulations do not restrict the mesh size used by subsistence fishers, and many choose to use large mesh sizes when targeting Chinook salmon. Large mesh size, as referred to in this report, is any stretched mesh size of 8 inches or larger. The 1994 annual subsistence survey included information about gillnet mesh sizes fishers used to harvest Chinook salmon. Of 497[1] respondents, 51% reported using mesh ≥ 8 inches, 44% used mesh ≤ 6 inches, and 5% used mesh sized between 6 and 8 inches (Francisco et al. 1995). In 1967, of 588 fishing families surveyed, 517 (88%) reported using "king nets" and 513 reported using "chum nets" for subsistence fishing (ADF&G 1968). The use of large mesh sizes is as much to target larger Chinook salmon as to avoid smaller species, whose numbers at times vastly exceeds Chinook salmon; however, most fishers do use both mesh types over the course of their annual salmon harvest activities. Gear usage in 2004 is thought to be closer to that reported in 1967 than 1994 based on comments from the Kuskokwim River Salmon Management Working Group (Working Group) and general conversations with subsistence fishers along the river.

Unlike subsistence fishers, commercial fishers have been required to use gillnet mesh sizes of ≤ 6 inches since 1985. The directed commercial fishery for Chinook salmon was discontinued in 1987 due to depleted runs and the importance of this species as a subsistence food. Incidental commercial harvest of Chinook salmon continues to occur during the June and July fishery that targets chum salmon (5 AAC 07.365, 2004).

Chinook salmon ASL information is typically collected from fish sampled from commercial harvest and escapements. These samples form the basis for a variety of investigations including pre-season run outlooks, assessment of the number of females and older aged fish in the escapement, and the development of spawner-recruit models used to estimate run productivity and as the basis of biological escapement goals.

Collecting ASL data from the commercial harvests and escapement-monitoring projects has been a standard part of the Kuskokwim Area salmon management program, but sampling subsistence caught fish is a more recent addition. Historically, the ASL composition of the subsistence harvest was estimated from commercial harvest samples (e.g. Huttunen 1986). Until 1985, this practice was reasonable, because the gear used for subsistence harvest was likely the same as the gear used during "unrestricted gear" commercial fishing periods, which is when most of the commercial Chinook salmon harvest occurred. After 1985, when the commercial fishery was restricted to mesh sizes ≤ 6 inches, ADF&G staff sometimes sampled subsistence caught Chinook salmon (Anderson 1991), but sex and length of the fish was typically unknown because collections were often limited to removing scales from fish that were already partially processed. In these instances, the sex composition of the subsistence harvest was based on samples collected from the restricted gear commercial fishery, which was likely not reflective of the actual sex

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[1] Francisco et al. (1995) lists total respondents as 490 (p. 29 and Table 26); however, as per discussion with Michael Coffing (ADF&G, Division of Subsistence, Bethel), the actual number of respondents was 497. The percentages presented in this report have been corrected accordingly.

composition of the subsistence harvest (DuBois and Molyneaux 2000; Molyneaux and Samuelson 1992). In some post-1985 years, the ASL composition of the subsistence harvest was estimated entirely from fish caught commercially with gillnets of ≤ 6-inch mesh size (Anderson 1995), which was also likely not reflective of the actual ASL composition (Molyneaux and Samuelson 1992).

Modest efforts to collect complete ASL data from subsistence caught Chinook salmon occurred in 1993, 1994, and 1995 as a pilot project that included enlistment of subsistence fishers and their families to collect the information (DuBois and Molyneaux 2000). The initiative was discontinued due to a lack of resources to execute the program. The program was re-established, and expanded, in 2001 through resources provided by the United States Fish and Wildlife Service (USFWS) Office of Subsistence Management (OSM) in coordination with the Division of Commercial Fisheries of the Alaska Department of Fish and Game (ADF&G) and various Tribal organizations (DuBois et al. 2002). For 2001 through 2003, 3 projects were funded by OSM, FIS 01-023 for the upper river, FIS 01-225 for the middle river and FIS 01-132 for the lower river. Each represented a partnership of ADF&G and a local Tribal organization from that respective portion of the river (Molyneaux et al. 2004a; b). Only the project for the lower Kuskokwim River continued in 2004. This report presents findings from the fourth year of this OSM sponsored program. Using only data collected from the lower river the objective is to estimate the ASL composition of the annual Kuskokwim River Chinook salmon subsistence harvest.

BACKGROUND

Subsistence fishing for Chinook salmon, as well as other species, occurs throughout the 1,548 river miles of the Kuskokwim River, and in many of the tributary streams. Fishing begins in the lower river in late May and extends through mid-July in the upper river. Salmon may be harvested by gillnet, beach seine, rod and reel, fish wheel, or spear (5 AAC 01.270, 2004). The aggregate length of set or drift gillnets cannot exceed 50 fathoms. Any mesh size may be used but, gillnets with ≤ 6-inch mesh must be < 45 meshes deep and nets with > 6-inch mesh may not exceed 35 meshes in depth. Rod and reel gear was recognized as a legal subsistence gear in the lower Kuskokwim River in 2000 (Ward et al. 2003), and then was adopted for the entire Kuskokwim River in 2001.

The annual subsistence harvest of salmon is estimated from harvest information collected during post-season surveys (Ward et al. 2003). ADF&G Division of Commercial Fisheries began the post-season surveys in 1960, and then the duty was transferred to the Division of Subsistence in 1988. Generally, subsistence harvest is estimated from house-to-house surveys, returned postcards and calendars, as is described in the annual management report (Ward et al. 2003). Village totals are estimated when survey data are expanded to include those individuals not surveyed. Village totals are summed for area and drainage-wide totals. Gear types used for subsistence salmon harvest have been reported since 1996, but details about mesh size are only available for 1967 (ADF&G 1968) and 1994 (Francisco et al. 1995).

Most of the subsistence Chinook salmon harvest occurs in the lower Kuskokwim River, especially in the Bethel area (Ward et al. 2003). In 2004, fishers in the lower Kuskokwim River accounted for 86%[2] of the total Kuskokwim River Chinook salmon subsistence harvest with

[2] Includes communities along the north end of Kuskokwim Bay.

Bethel households accounting for 32% of the total river harvest. In contrast, fishers in the middle and upper Kuskokwim River accounted for about 10% and 4% of the harvest.

Commercial fishing is mostly limited to a 128-mile span of the lower Kuskokwim River, District W-1 (Figure 1). Though 2 commercial fishing districts have been defined for the Kuskokwim River the commercial fishery is restricted to District W-1 because of market preferences. Commercial fishing has occurred in District W-2 only once since 1998 and it remained closed in 2004. Directed commercial fisheries for Kuskokwim River Chinook salmon have not been allowed since 1987 (Ward et al. 2003). Chinook salmon are harvested incidental to the directed chum salmon fishery. The Chinook salmon harvest in 2004 was 2,300 fish, well below the 10-year average of 7,383 fish (Martz and Whitmore 2005).

The Alaska Board of Fisheries (BOF) recognized Kuskokwim River Chinook salmon as a "yield concern" in October of 2000 (Burkey et al. 2000) and again in September of 2003 (Bergstrom and Whitmore 2004). Escapement goals were generally not achieved in 1998, 1999, and 2000 despite little commercial fishing effort and an annual fishing schedule was imposed on subsistence fishers beginning in 2000. Escapements improved in 2001 and 2002 (Ward et al. 2003) and were even greater at most locations in 2003 and 2004. Currently the Kuskokwim River is being managed under a rebuilding plan for Chinook salmon, as well as chum salmon as described in 5 AAC 07.365.

Part of the rebuilding plan establishes a subsistence fishing schedule in June and July, in which subsistence fishing with gillnets and fish wheels is limited to a window of 4 consecutive days each week (5 AAC 07.365, 2004). The schedule can be modified or discontinued depending on the fishery manager's assessment of the adequacy of salmon abundance to achieve escapement and subsistence needs. The intent of the fishing schedule, as presented to the Alaska Board of Fisheries in 2001 and amended in 2004 (Bergstrom and Whitmore 2004), was to reduce subsistence fishing time early in the run to help ensure that subsistence harvests do not impair meeting escapement needs or "reasonable opportunity for all subsistence users" (Burkey et al. 2000). The objective states: "Reduce subsistence harvest early in the season when there is a much higher level of uncertainty in projecting total run abundance and spread subsistence fishing opportunity among users". In addition, there was discussion, and general agreement, among staff and board members that another benefit of the subsistence fishing schedule would be to increase the number of female Chinook and larger Chinook salmon passing upstream of the lower Kuskokwim River, including into lower river tributaries.

STUDY AREA

The study area for 2004 was reduced from previous years (Molyneaux et al. 2004b) to the lower river, which ranges from near the mouth to the village of Tuluksak (rm 120). Samples were collected from Bethel and the nearby villages of Tuntutuliak (38 rm from Bethel), Akiachak (23 rm), and Kwethluk (16 rm) (Figure 2). Historically the study area partitioned villages and associated fish camps into 3 reporting areas, the lower, middle, and upper river which corresponds to historical data. The lower Kuskokwim River ranges from near the mouth to Tuluksak (rm 120), the middle Kuskokwim River ranges from just below Lower Kalskag (rm 161) to Chuathbaluk (rm 201), and the upper Kuskokwim River includes all villages upstream of Chuathbaluk. Subsistence survey data from the river when divided into these 3 segments shows differing proportions in gear type usage (Table 1). Drift gillnets are most prominent in the lower river, although many fishers do use set gillnets early in the season when the density of fish is lower.

The lower Kuskokwim River reporting area is further partitioned into 2 sub-areas for clarifying responsibilities between Orutsararmiut Native Council (ONC) and ADF&G. ONC coordinated sampling in the Bethel sub-area, which ranged from Napaskiak (rm 60) to the mouth of the Gweek River (rm 84). ADF&G coordinated sampling in the second sub-area, which consisted of all villages and fish camps of the lower Kuskokwim River that were outside of the Bethel sub-area (Figure 2).

OBJECTIVES

Objectives for the USFWS OSM project FIS 04-353, *Bethel Area Inseason Subsistence Salmon Catch Monitoring Data Collection* include:

1. Determine the adequacy and quality of fish harvested by conducting weekly interviews of subsistence salmon fishers in the Bethel area (approximately from Napaskiak to Kwethluk River).
2. Provide oral and written summaries of interview findings to ADF&G, USFWS, local Federal Regional Advisory Council members, State Fish and Game Advisory Committees, and the Working Group weekly, on the Monday following the interview week, so the information would be available to assist in inseason fishery management decisions.
3. Estimate the age, sex, and size composition of the Chinook salmon harvested in the lower Kuskokwim River subsistence fisheries.

Results from objectives 1 and 2 are not included in this report. Objective 1 and 2 were addressed by Martz and Whitmore (2005).

METHODS

SAMPLE COLLECTION

Most Chinook salmon ASL information collected through this program was gathered by non-agency participants that included subsistence fishers, subsistence household members, or other community members who sampled fish caught near their local communities or fish camps. Participants were trained in sampling technique by technicians and biologists from the coordinating agencies of ADF&G and ONC. Participants collected samples from their own harvest and or the harvests of others. Sample limits (number of fish samples) were not placed on individual participants though participants were selected as being willing to sample all season, sample all fish during each event, and were encouraged to sample other fish camps.

ADF&G staff contacted prospective participants throughout the 2004 study area based upon referrals from village organizations or selected contacts. Persons interested in participating in the sampling program were trained to collect ASL data following ADF&G protocols, modified slightly from those used by ADF&G. Each sampler (participant) was provided with a sampling kit that included a meter stick, gum cards, wax paper inserts, forceps, data forms, pencils, and a clipboard with attached sampling instructions. The sampling form was a simplified modification of the mark–sense form typically used by ADF&G (Appendix A1). Information collected from each fish included 3 scales for age determination, sex, length, gear type, mesh size, date and location of capture, and sampling participant's name. Staff from ADF&G and ONC conducted follow-up visits to the participants to gather completed samples and to review the information for accuracy. The information was then delivered to the ADF&G Bethel office for processing. Participants were paid for the information they collected, with payment arranged through ONC in the Bethel sub-area or ADF&G in all other villages where the samples were collected, or the community where the person was a resident.

Sample Design

The 2004 objective was to characterize the age, sex, and length of the Chinook salmon subsistence harvest in the lower Kuskokwim River. Fishing for Chinook salmon begins in the lower river in late May and extends through mid July. Effort and harvest success may vary by week and is unknown. Harvest by gear type is also unknown. We collected as many ASL samples as possible throughout the months of May, June, and July to most accurately reflect what is occurring in the lower river fishery. We are conducting what Geiger et al. (1990) termed a "grab sample" in that we lacked the guarantee that each Chinook salmon in the harvest had an equal chance of selection (random sample) or that every i^{th} fish would be sampled (systematic sample). Gathering an ASL sample would be very opportunistic and would be tied to availability of time and area of fish, and samplers. We assumed that large sample sizes collected in the "grab" sample strategy was influenced by the availability of fish and samplers through time and locations. If sampling participants expend effort (sampling their own and or looking for the harvests of others) in an attempt to collect many samples then the assumption would be that when many fish are available (harvested) many samples would be collected and therefore be self-weighting by gear and area over the time period and in the area samplers are working. In summary it was hoped that if samplers look for Chinook salmon to sample every day during a weekly subsistence period (i.e. consistent searching effort) more samples will be collected on days that more fish are harvested. This would more likely be true of community and household participants that sample fishers outside or in addition to their own household. This assumption is necessary if samples pooled through time are thought to be representative of the post-season harvest estimate.

The grab sample design (Geiger et al. 1990) was used to sample the Kuskokwim River subsistence Chinook fishery during 2004. ONC and ADF&G recruited as many participants as possible to collect as many samples as possible from the lower river area, with no intentional focus on gear type when recruiting participants. All samplers that were interested were encouraged to participate. The tentative sample goal (needed to purchase equipment and develop budgets) was 2,000 for the lower Kuskokwim River (1,500 by ONC and 500 by ADF&G). Samples from the lower river were to be used to apportion the harvest estimate from that area by age and sex. Large samples for any reporting area would also allow us to retrospectively stratify by time and gear.

For future consideration is the possibility that most variation in these ASL samples is among fishers and not individual Chinook salmon. If that is the case, we would consider optimizing the number of fishers to sample. That analysis is outside the scope of the project for 2004 but should be considered in the future. A look at components of variation may give some insight into sampling. Analysis like this may allow us to focus our sampling more efficiently.

Sampling Procedures

Sampling methods followed routine procedures outlined by ADF&G protocols (DuBois and Molyneaux 2000). Three scales were removed from the preferred area of each Chinook salmon and mounted on gum cards (INPFC 1963). The clipboard provided to each participant included a laminated instruction sheet that illustrated the sampling procedure (Appendix A2). Participants were instructed to determine the sex of each fish by cutting the fish and inspecting internally for gonads. Length was measured to the nearest millimeter from mideye to tail fork using a meter stick to provide a straight-line measurement. The participants recorded their name, address, scale card number, date of harvest, location of harvest, gear type, and mesh size if applicable, on a rite-in-rain data form along with the sex and length information of each fish (Appendix A1).

AGE DETERMINATION

Age is determined from the annuli of scales taken from the preferred area of the fish (INPFC 1963). The scales, which are mounted on gum cards, are impressed in cellulose acetate using methods described by Clutter and Whitesel (1956). The scale impressions are magnified with a microfiche reader and age is determined through visual identification of annuli. Ages are directly entered into the computer ASCII files using European notation. In European notation 2 digits are separated by a decimal and refer to the number of freshwater and marine annuli respectively. The first digit represents the freshwater age minus one. The second digit represents the number of annuli formed during the marine residency. Total age from brood year is the sum of the 2 ages plus one.

DATA PROCESSING, ANALYSIS, AND REPORTING

ASL data collected from the Kuskokwim River subsistence Chinook harvest were entered directly into a computer ASCII file. The ASCII files were processed through a number of programs and compiled to produce age-sex and length summary tables. The age-sex table describes the age and sex composition for each stratum as a percentage based on the stratum sample. The length table for each stratum includes statistics on mean length and the range of lengths in each age-sex category.

Chinook salmon ASL data were stratified by week from the lower river, as defined in our study area description. In order to investigate differences in ASL composition among mesh sizes, data were further stratified by 3 gillnet mesh size ranges: (1) ≤ 6 inches, (2) > 6 inches but < 8 inches, and (3) ≥ 8 inches. Samples from drift and set gillnets were pooled within each mesh size. Sufficient samples were collected from ≥ 8-inch mesh gillnets to divide ASL data into temporal strata based on the weekly subsistence fishing schedule in order to investigate differences in ASL composition through time.

Data corresponding to each gear, or time stratum were summarized for age, sex, and length composition. The percent by age and sex was calculated for each stratum sample, as was a mean length by age and sex. Data were then pooled across time strata for mesh sizes > 8 inches and summarized for ASL composition. Next, data were pooled across gear types and summarized for ASL composition representative of the lower river. The post-season subsistence harvest survey estimates harvest by area and lacks harvest by time period, by gear type, or gillnet mesh size.

The percent by age and sex calculated from all data was multiplied by the estimated subsistence harvest from the lower river area (Appendix B1) to obtain the number of Chinook salmon estimated to be of a particular age and sex (for example age 1.2 males for the lower Kuskokwim River). The age and sex composition estimated from lower river samples was also multiplied by the total river harvest which includes the middle and upper river area to obtain the number of Chinook salmon estimated by age and sex.

AGE, SEX, AND LENGTH COMPOSITION ESTIMATES FROM THE COMMERCIAL HARVEST AND TRIBUTARY MONITORING PROJECTS

Estimates of the ASL composition of Chinook salmon in the District W-1 commercial harvest and of Chinook salmon spawning above the 6 tributary monitoring projects (Figure 1) was compared to ASL estimates from the lower river subsistence harvest. Samples from the subsistence harvest, commercial harvest, and escapement projects were all processed by the same staff for age determination and data collection protocols were similar (length measurements, scale choice, etc.). ASL compositions used in this comparison represent those subsequently published in annual project reports. The commercial harvest was sampled by ADF&G staff following procedures by DuBois and Molyneaux (2000). Staff sampled Chinook salmon from each commercial fishing period with a sample size goal of 210 Chinook salmon collected from at least 6 different fishing vessels.

ASL compositions of Chinook salmon escapements monitored at the Kwethluk River weir (Roettiger et al. 2004), Tuluksak River weir (Zabkar and Harper 2004), Kogrukluk River weir (Shelden et al. 2004), George River weir (Linderman et al. 2003), Tatlawiksuk River weir (Linderman et al. 2004), and Takotna River weir (Gilk and Molyneaux 2004) were estimated by sampling a fraction of fish passage and applying the ASL composition of those samples to total annual escapement as described in DuBois and Molyneaux (2000). A pulse sampling design was used for Chinook salmon, in which intensive sampling was conducted for 1 to 3 days followed by a few days without sampling. The goal for each pulse was to collect samples from 210 Chinook salmon. These sample sizes were selected for simultaneous 95% confidence interval estimates of age composition proportions no wider than 0.20 (Bromaghin 1993). The minimum number of pulse samples was one from each third of the run. The season total minimum was 210 Chinook salmon sampled from the duration of the run if pulse sample size goals were not met.

RESULTS

SAMPLE SIZE AND GEAR TYPES

In 2004, 21 participants collected 2,290 Chinook salmon ASL samples from subsistence harvests in the lower Kuskokwim River. All Chinook salmon were caught with drift or set gillnets, with ≥ 8-inch mesh accounting for 91%, > 6-inch mesh 5%[3], and ≤ 6-inch mesh 4% of the sample. Fifteen participants collected 1,715 ASL samples from the Bethel area with ≥ 8-inch mesh accounting for 67%, > 6-inch mesh 5%, and ≤ 6-inch mesh 3% (ONC samples) of the total samples. Six participants collected 575 samples from the communities of Tuntutuliak, Kwethluk, and Akiachak with ≥ 8-inch mesh accounting for 24%, > 6-inch mesh 0%, and ≤ 6-inch mesh 1% (ADF&G samples) of the total samples (Table 2). Age was determined for 1,979 of the fish sampled, which was 2.5% of the estimated 80,065 Chinook salmon harvested in the 2004 Kuskokwim subsistence fishery (Appendix B1). Samples from drift and set gillnets were pooled by mesh size category for estimates of age and length composition. The number of participants represents a minimum number of harvests sampled as most participants sampled harvests in addition to their own.

[3] Represents samples from gillnets with mesh sizes > 6 inches and < 8 inches.

AGE, SEX, AND LENGTH COMPOSITION OF SUBSISTENCE FISHERY SAMPLES

Chinook salmon sampled from the 2004 lower Kuskokwim River subsistence fishery were caught with gillnets spanning 7 mesh sizes (5½-, 6-, 6½-, 7½-, 8-, 8⅛-, and 8¼-inch mesh). The ASL composition of Chinook salmon was grouped by mesh size (≥8-inch mesh, >6-inch mesh, and ≤6-inch mesh). Participants reported that sex determination for all Chinook salmon samples was verified by cutting the fish and looking for eggs. Of the 2,290 samples collected, ages were identified for 1,979 Chinook salmon (86%).

Age composition, pooled across all gillnet mesh sizes sampled from the lower Kuskokwim River, was 46.5% age-1.4 fish, 36.5% age-1.3 fish, 13.9% age-1.2 fish, and 2.6% age-1.5 fish (Table 3). The prevalence of age-1.4 Chinook salmon increased with increasing mesh size (Figure 3): 16.3% SE = 5.6 (≤ 6 inch), 20.2% SE = 4.0 (6½ to 7⅞ inch) and 48.6% SE = 1.2 (≥ 8 inch). Age-1.3 Chinook salmon comprised varying percentages among mesh sizes but the percentages did not increase with increasing mesh size (34.9% SE = 7.3 in ≤ 6 inch, 31.3% SE = 4.7 in 6½ to 7⅞ inch, and 36.8% SE = 1.1 in ≥ 8 inch). Age-1.2 fish occurred most frequently in the ≤ 6-inch mesh size, where they accounted for 48.8% (SE = 7.6) of the samples.

Sex composition of aged samples pooled across all gillnet mesh sizes was 32.5% female. The composition by gillnet mesh size category was: 7.0% female for ≤ 6-inch mesh, 12.1% for 6½- to 7⅞-inch mesh, and 34.2% for ≥ 8-inch mesh (Table 3). The percent female of an age category ranged from 0.7% of age-1.2, 14.5% of age-1.3, 54.8% of age-1.4, to 40.4% of age-1.5 Chinook salmon, for all gillnet mesh sizes pooled.

Length composition of aged samples from the lower Kuskokwim River varied by sex and gear type (Table 4). Overall, females tended to be larger at age than males. Generally, mean length at age also increased with an increase in mesh size of the capture gear but was a more consistent pattern for males than females.

TEMPORAL PATTERNS IN AGE, SEX, AND LENGTH COMPOSITION OF SUBSISTENCE FISHERY SAMPLES

A total of 1,837 samples collected from subsistence harvests with gillnets of ≥ 8-inch mesh size in the lower Kuskokwim River were aged allowing us to investigate temporal patterns in the ASL composition. Data were stratified around weekly subsistence periods; May 30 through June 5, June 9 through June 12, June 16 through June 19, and June 20 through July 19 (Table 3). Days between these weekly strata were closed to subsistence fishing with gillnets for the first 2 weeks. The subsistence schedule was lifted on June 18 for the remainder of the season and fishing was allowed 7 days per week.

The age composition varied slightly among weekly strata for the Lower Kuskokwim River subsistence fishery (Table 3). The youngest age-1.2 fish were most prevalent in the third week, June 16 through 19, while the largest proportion of age-1.5 Chinook salmon (10.8%) occurred during the first week, May 30 through June 5. Any pattern of changing composition over time by age-sex category (Table 3) or mean length by age-sex category (Table 4) was not apparent in June.

SUBSISTENCE HARVEST AGE, SEX, AND LENGTH COMPOSITION

The total estimated subsistence harvest of Kuskokwim River Chinook salmon in 2004 was 80,065 with 68,559 Chinook salmon (86%) harvested in the lower river, 8,007 (1%) in the middle river, and 3,499 (4%) in the upper river (T. Krauthoefer, Division of Subsistence, ADF&G, Bethel; personal communication; Appendix B1). Harvests from the lower river were apportioned to age and sex (Table 5) using the ASL composition of samples pooled by mesh size from Table 3. Samples were not collected from the middle and upper river and those harvests were not apportioned to size and sex. The lower river ASL composition was applied to the total river harvest (Table 5 and Table 6). The 2004 harvest included 29,224 age-1.3 (36.5%), 37,230 age-1.4 (46.5%), 11,129 age-1.2 (13.9%), and 2,082 age-1.5 (2.6%) Chinook salmon. Estimated sex composition was 54,044 males (67.5%) and 26,021 females (32.5%). Eighty-six percent of the harvest was taken in the lower river, including 22,282 female Chinook salmon. A summary of findings from the 2004 sampling program was distributed to participants and interested groups in April 2005 (Appendix A3). Generalizations on mesh sizes used and ASL composition were presented in graphical and text format. Comparisons of age class from subsistence samples, escapement projects, and commercial samples were reported. Information also included acknowledgment of funding groups and the participating agencies.

COMPARISON OF SUBSISTENCE, COMMERCIAL, AND ESCAPEMENT AGE, SEX, AND LENGTH COMPOSITIONS

Estimates of Chinook salmon age composition in the subsistence harvest differed from that estimated for tributary escapements and the District W-1 commercial harvest (Table 7; Figure 4) in 2004. The most notable difference is that male age-1.2 Chinook salmon comprised 13.8% of the subsistence harvest, 57.8% of the commercial harvest, and 34.5% of the escapement as averaged across 5 monitored tributary escapement projects[4]. Estimates at escapement projects ranged from 22.1% to 56.1%, and are all above the 13.8% observed in the subsistence fishery. Furthermore, age-1.4 and -1.5 Chinook salmon, combined, were 48.7% of the subsistence harvest, 15.2% of the commercial harvest and averaged 31.8% of the escapement (Table 7; Figure 4). The proportion of age-1.3 fish in the subsistence harvest, however, was similar to the escapement average (36.5% versus 32.6%) both larger than the commercial harvest of 25.4%.

The subsistence harvest included a percentage of female Chinook salmon (32.5%) that was also similar to the escapement average of 27.8% (Table 7). Furthermore, the 32.5% female observed in the subsistence fishery was within the range of percentages observed at the 6 escapement projects (16.4% to 35.6%). In contrast, the percentage of female Chinook salmon estimated in the commercial harvest (10.5%) was less than that estimated at any escapement project and considerably less than the subsistence harvest.

Average length, by age-sex category, of Chinook salmon sampled from the subsistence harvest was well within the range of average lengths observed in the 5 escapement projects and commercial harvest (Table 7; Figure 4). Mean length at age was nearly identical for most ages.

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[4] Samples from the Takotna River weir were omitted. Samples were not collected throughout the duration of the run and were too few to characterize the 2004 escapement.

DISCUSSION

TOTAL KUSKOKWIM RIVER SUBSISTENCE HARVEST

Several assumptions underlie our estimate of the ASL composition of the Chinook salmon harvest from the Kuskokwim River. Their fulfillment affects the accuracy of our estimates and conclusions we draw from ASL patterns observed across time, area, and gear. The actual harvest of Chinook salmon by weekly fishing period or by gear type is unknown. We (1) assume that our samples are representative of the harvest by gear type and we (2) assume sampling is in proportion to abundance through time such that pooled samples by reporting area across time represent the true ASL composition of the season total harvest for that reporting area (lower, middle, upper). To varying degrees, like assumptions apply to escapement and commercial catch sampling programs.

During postseason subsistence harvest surveys, fishers are asked the type of gear they use to harvest salmon (Table 1). These estimates of gear usage are not specific to Chinook salmon nor is the mesh size for gillnets reported. Most likely Chinook salmon are targeted by all the major gear groupings. For example, fish wheels are not an efficient gear for Chinook salmon, but very few fish wheels are used, and none were reported used in 2004 in the lower river. It is also unknown what percent of the harvest is taken by each gear type. For example, 21% of households report using rod and reel gear to harvest subsistence salmon, but it is likely that far less than 21% of Chinook salmon is harvested with that gear given its lower efficiency compared to gillnets. Seventy-nine percent of households use gillnets, and it is likely that even a greater percent of the harvest is taken with that gear. All samples in 2004 were of gillnet caught Chinook salmon from the lower river subsistence fishery. We assert, given 84% of the fishers used gillnets and caught 86% of the total river subsistence harvest, project samples adequately represent the total harvest.

We also think an adequate job was done characterizing the harvest through time in the lower river. If there are changes in ASL composition through time, then samples need to be representative of abundance in order to be pooled and accurately represent a season total. Sampling occurred throughout the Chinook salmon run in 2004 and most samples came from the first week in June when historic catch calendar analysis indicates that most of the harvest occurs. This was improvement from 2003 when peak sampling during the second week of June was thought to be associated with the delayed distribution of sampling kits rather than level of harvest.

In 2004 only Chinook salmon harvested in the lower river subsistence fishery were sampled. The resulting ASL composition was then applied to the entire harvest (Table 5). We assert that because the lower river represents 86% of the total river harvest its estimated ASL composition adequately represents the ASL composition of the total harvest. We also note from sampling in 2002 and 2003 (Molyneaux et al. 2004a; b) that the ASL composition in the upper and middle river areas differed from the lower river. We observed from 2002 and 2003 when all data were pooled and the age-sex composition of the total harvest estimated it differed from the lower river area age-sex composition by less than 0.7% in 2003 and 0.8% in 2004 for any age-sex category.

The Chinook salmon subsistence harvest in 2004 (80,065) was the highest since 1998 (81,265) and higher than previous project years of 2003 (67,788), 2002 (66,807), and 2001 (73,610). The estimated age composition of the 2004 harvest was notably different than other project years (Table 6) with a large percent of age-1.2 Chinook salmon (13.9%), nearly double the next largest value of 7.8% in 2002. The percent of age 1.3 and 1.4 were more similar to 2003 than earlier years. The percent female (32.5%) was slightly lower than the next lowest value of 35.4% in 2001.

In 2004, 99% of the sampled age-1.2 Chinook salmon were reported to be male, which was unlike 2002 when the proportion of females was thought to be biased high (Molyneaux et al. 2004a) due to erroneous sex determination. This is similar to what was found in sex confirmed fish sampled by ADF&G where less than 1% of the aged-1.2 Chinook salmon were female (DuBois and Molyneaux 2000). ADF&G samples consisted of 789 Chinook salmon from the Kuskokwim River commercial fishery in 1997, 1998, and 1999. The 2003 subsistence samples (DuBois et al. 2002) had an incidence of female age-1.2 Chinook salmon more comparable to that found in the ADF&G sex-confirmed fish.

Correct sex determination has been a challenge in other salmon ASL data sets (e.g., DuBois and Molyneaux 2000; Linderman et al. 2003). The subsistence ASL sampling program sought to address this challenge by directing participants to confirm the sex by cutting the belly of the fish, then inspecting internally for the presence of eggs. In 2002 it was suspected that all participants may not have diligently followed the directive, but compliance is thought to have improved markedly in 2003 and 2004 due to field staff from the coordinating organizations stressing the need for sex confirmation to participants. This education effort should be continued in order to insure sustained compliance and data accuracy.

Part of the intent in estimating the ASL composition of the subsistence harvest is to reconstruct the total Kuskokwim River Chinook salmon run, which in time, could be used to develop brood tables for determining overall Chinook salmon productivity. Apportioning the subsistence harvest by ASL composition is one of three components in achieving this goal. The second component is apportioning the commercial harvest by its estimated ASL composition. Few Chinook salmon have been harvested since 2000 though the increased harvest in 2004 was sampled. The third component is estimating the total escapement and its ASL composition. The third goal has not yet been achieved, however, progress has been made through the operation of the mainstem radio telemetry project in combination with marked to unmarked ratios recorded at the array of weir projects where Chinook salmon escapement and ASL information are collected (Stuby 2003, Stuby 2004, *In prep*).

Comparison of Subsistence, Commercial, and Escapement Age, Sex, and Length Compositions

The difference in the age composition of Chinook salmon in the subsistence harvest, the commercial harvest, and in the escapement is attributed to the selectivity of gillnets used in the fisheries. Gillnets hung with ≥ 8-inch mesh sizes are the most prominent gear type used in the subsistence fisheries for Kuskokwim River Chinook salmon and represented 80% of the samples in 2004. The selectivity of these nets, by default, reduces the number of older aged fish and females in the escapement, and increases the percentage of predominantly male age-1.2 fish on the spawning grounds (ADF&G 1981). This becomes a significant factor as exploitation increases. In contrast, the commercial fishery is restricted to a maximum mesh size of 6 inches which selects for smaller and younger Chinook salmon which are predominately male (57.8% age 1.2). Furthermore the commercial harvest was only 2,300 Chinook salmon in 2004 and represents low exploitation with little impact on the ASL composition of the escapement.

Two implications come to mind as to the significance of the imbalance between escapement, subsistence, and commercial ASL composition. First is that the resulting escapements have reduced egg laying potential due to the reduction of females, and especially the reduction of the larger more fecund females (ADF&G 1981; Ricker 1980). This also brings into question the utility of escapement goals that do not take into account sex composition and the egg laying potential of annual escapements. In the Tuluksak River, for example, the proportion of female Chinook salmon has been reported as low as 14% (Harper 1995).

The second implication harkens to a question posed by Nickie Mellick, a recently deceased Kuskokwim River elder, who asked, “Why don’t we see the abundance of large Chinook salmon like we once did?” The answer may be that we are fishing them out. Age at maturity in Chinook salmon is known to have a heritable component (Hankin et al. 1993). Large mesh gillnets act as a directional evolutionary force on a Chinook salmon population, whereby the introduction of a relatively new environmental influence results in a discrete segment of the population having a lower breeding success than the rest of the population. Experimental selective harvest of large individuals from fish populations has been found to reduce the average body size at age over successive generations (Conover and Munch 2002); moreover, there are numerous examples where size selective harvest is believed to have resulted in reduced average body size at age and average age of maturity in various salmon populations over timescales of 20 years or more (ADF&G 1981; Bigler et al. 1996; Ricker 1980; Thorpe 1993).

Modeling experiments using available genetic data show that modest shifts in Chinook salmon average size at age can occur in responses to directional selection (Hard 2004). The degree of reduction depends on harvest rate, the harvest size threshold, and the strength of stabilizing natural selection on size. Detectable change, however, could occur in as few as 3 generations if the selectivity is intense, or may require many dozens of generations if the selectivity is less intense or somehow mitigated.

Thorpe (1993) also cautions that the social and economic pressures of fishery management must balance with the realization that the stock structure of salmonid populations is adaptive. There is evidence that discontinuing the use of large mesh gillnets may result in a return of the larger and older Chinook salmon (J. H. Clark, Fisheries Scientist, ADF&G, Juneau; personal communication), but suggesting the discontinuation of large mesh gillnets in the Kuskokwim River subsistence fishery would be met with strong public disfavor. Even discontinuing harvest, however, does not guarantee selection back to the original state (Conover and Munch 2002).

According to Conover and Munch (2002), long-term sustainable yield requires management practices to incorporate tools that preserve natural genetic variation, such as the use of harvest methods that mirror genetic variation. This strategy was also discussed by ADF&G (1981) in considering the required use of smaller mesh gillnets, but such an action would again meet with considerable social resistance in the Kuskokwim Area, create a concern for “dropouts,” and result in an increased harvest of non-target species such as chum salmon.

Another alternative is that management programs incorporate “disruptive selection” practices as described by Hard (2004). Such practices can substantially reduce the strength of selection on size if a sufficient proportion of large fish escape fishing related mortality. A form of disruptive selection is currently practiced in the Kuskokwim River through the subsistence fishing schedule instituted in 2001 (Burkey et al. 2000). The evolutionary significance of the schedule was not part of the original argument for its implementation, but continued use of the schedule may be a prudent long-term management strategy considering the findings described by Hard (2004).

INFLUENCE OF THE SUBSISTENCE FISHING SCHEDULE

Part of the intent of the subsistence fishing schedule, as discussed during deliberations at the January 2001 BOF meeting, was to increase the number of larger (i.e., older aged) Chinook salmon in the escapement and to increase the number of female Chinook salmon in the escapement. This was thought to occur as Chinook salmon passed upriver during closed periods immune from the selective removal of large mesh gillnets. Assessment of the effectiveness of the schedule to achieve these goals would require a comparison of 2 different sets of subsistence and escapement ASL data: one set collected when the subsistence fishing schedule is in effect, and another when the schedule is not in effect. The relative difference between the subsistence and escapement ASL compositions, with and without the fishing schedule, should provide insight into the effectiveness of the schedule at achieving the intended goals. Furthermore, this will need to occur over a number of years as differences between the harvests under each management regime would be confounded with the underlying differences in brood year strength in Chinook salmon for those years.

TEMPORAL PATTERNS IN AGE, SEX, AND LENGTH COMPOSITION OF SUBSISTENCE FISHERY SAMPLES

When viewed from a given point along the migratory route, the ASL composition of salmon populations sometimes change as the run progresses through time (DuBois and Molyneaux 2000). The Chinook salmon harvest from the Kuskokwim River subsistence fishery was investigated for such patterns by stratifying samples by specific harvest dates. The ASL composition for Chinook salmon harvested in the lower Kuskokwim River (Figure 5) varied little by time period and lacked a trend. The percentage of female Chinook salmon also remained constant through time in the lower Kuskokwim River subsistence fishery. It is not surprising that the fishery sample did not show a temporal pattern as it is composed of many stocks of Chinook salmon bound for spawning locations throughout the drainage. Radio telemetry studies have found that upriver stocks have earlier run timing than lower river stocks (Stuby 2003, 2004, *In prep*). Even if each stock displayed a temporal trend in proportions by size, age, or sex the differences among overall migration timing of stocks could mask any trend discernable from a mixed stock sample such as harvest samples.

ADEQUACY OF SAMPLE SIZES AND PARTICIPATION

Ideally, ASL sampling should be in proportion to the harvest by gear, through time, and by location as we pool samples by area to apply to harvest by area. We do not know, however, the harvest by gear type nor through time. The current strategy is simply the more, the better, hoping that intensive sampling will weight towards the gear most commonly used and that harvests the most Chinook salmon. We are hoping to closely approximate proportional sampling. Design variables to be accounted for include harvest derived from many different gillnet mesh sizes, rod and reel gear, and fish wheels. Furthermore, gillnets can be fished either as set or drift nets, which may also influence the ASL composition of the harvest. The ASL composition is also influenced by the hanging ratio, which fishers may vary depending on the continuum of preference between harvesting fish by gilling or tangling. These variables are compounded by changes in the ASL composition over time, distance upstream, and by changes in preferred fishing methods over time or location. Adequately adjusting for all these variables is a challenge. The current sampling strategy has 3 parts:

1. Begin sampling at the start of the season and encourage participants to continue sampling through the end of their harvest season. This helps account for changes in ASL through time, or changes in harvest effort or success through time.
2. Sample as many fish as you can from each reporting area. Again we are hoping that intensive sampling self weights towards the most successful gear in terms of harvest taken.
3. Sample from as many fishers as you can from each reporting area. This helps account for use of various mesh sizes.

Additional challenges are enticing subsistence fishers to participate in the program, and ensuring the quality of the information being collected. The primary enticement for subsistence fishers is the monetary payment associated with the fish they sample. Critics site that the payment method creates an incentive for dishonest sampling practices, but to date we do not have any known incidences of such practices. This continues to be a concern, however, that program managers need to monitor as part of the standard information quality assessment, and the same concern applies to all ASL sampling programs.

Efforts to monitor the quality of the information being collected occur through careful training of prospective participants, followed with repeat site visits, and careful review of the information participants submit. Participants are encouraged to submit samples early and often in order to allow program managers early and repeated opportunity to inspect for problems. The primary challenges are simply helping participants keep information organized so that fish scales can be matched with the correct sex and length data, plus ensuring that participants are diligent about confirming the sex of fish. This challenge can be addressed in large part by developing a pool of quality samplers that participate in the program each year, but this advantage is undermined if annual program operations are discontinuous due to inconsistent funding.

Even with the monetary payment, over half the individuals trained and outfitted with sampling kits decided not to participate. Some cite the tedium of the task as the reason they opt out, others cite the inadequacy of the monetary compensation or they have difficulty modifying their routine to accommodate the sampling needs. The task of recording and organizing the information is daunting enough to dissuade some prospective participants, although the simplified data form helps (Appendix A1).

Not withstanding these hurdles, enlisting user participation has resulted in much improved information gathering. Formerly, ADF&G staff attempted to characterize the ASL composition of the subsistence harvest by using commercial catch samples as a surrogate (Anderson 1995; Huttunen 1986; Molyneaux and Samuelson 1992), or by traveling to fish camps to opportunistically sample freshly caught Chinook salmon (Anderson 1991; DuBois and Molyneaux 2000). Coordinating sampling trips with fish availability, however, was unproductive. Furthermore, most often, the gear type in which the fish were caught was unknown, and the length and sex of the fish could not be determined because of fish being partially processed at the time ADF&G staff arrived. In some incidences, ADF&G staff may have sampled an individual fish multiple times, as they sometimes resorted to ripping scales from strips hanging on the drying racks. Another hindrance of past practices was the intrusion, as some viewed it, of ADF&G staff entering fish camps and handling fish that was being prepared for family consumption. In all, these past practices were simply inadequate for gathering samples in a manner sufficient to characterize the subsistence harvest. Despite a few shortfalls, the current user involvement method is vastly superior to past practices. Furthermore, the current method, arguably, is the most cost effective means of gathering such information.

CONCLUSIONS

TOTAL KUSKOKWIM RIVER SUBSISTENCE HARVEST

- Age composition of the 2004 Kuskokwim River subsistence harvest (Table 5) included 37,230 age-1.4 (46.5%), 29,224 age-1.3 (36.5%), 11,129 age-1.2 (13.9%), and 2,082 age-1.5 (2.6%) Chinook salmon.
- Sex composition of the harvest (Table 5) included 54,044 males (67.5%) and 26,021 females (32.5%).
- The 2004 harvest included the highest estimated percent of age-1.2 Chinook salmon and the lowest estimated percent female since the project began in 2001.

COMPARISON OF THE SUBSISTENCE, COMMERCIAL, AND ESCAPEMENT AGE, SEX, AND LENGTH COMPOSITIONS

- Age composition of the subsistence harvest differed from escapements and the commercial harvest (Figure 4).
- Age-1.2 male Chinook salmon comprised 13.8% of the subsistence harvest, 57.8% of the commercial harvest, and escapement averaged 34.5%.
- Age-1.4 and -1.5 Chinook salmon comprised 48.7% of the subsistence harvest, 15.2% of the commercial harvest, and escapement averaged 31.8%.
- Age-1.3 Chinook salmon were similar in the subsistence harvest and escapement average (36.5%, 32.6%) but lower in the commercial harvest (25.4%).
- The percentage of female Chinook salmon in the subsistence harvest and the average for escapements was similar (32.5% and 27.8%) but lower (10.5%) for the commercial harvest.
- Average lengths by age-sex category were comparable (Figure 4).

INFLUENCE OF THE SUBSISTENCE FISHING SCHEDULE

- Available information is yet insufficient to determine whether the subsistence fishing schedule is an effective management tool for increasing proportion of older aged fish and female Chinook salmon up stream of the lower Kuskokwim River. Missing is a comparable dataset collected without the influence of the fishing schedule and the number of years needed to account for variable year class strength. Missing also are ASL composition estimates of the middle and upper Kuskokwim River subsistence harvests.

TEMPORAL PATTERNS IN AGE, SEX, AND LENGTH COMPOSITION OF SUBSISTENCE FISHERY SAMPLES

- The ASL composition was relatively uniform over time for Chinook salmon harvested in the lower Kuskokwim River subsistence fishery (Figure 5).

ADEQUACY OF SAMPLE SIZES AND PARTICIPATION

- It is unknown how representative samples are of total harvest. We assume ASL composition of pooled samples are adequate to represent total harvest from the post-season survey.
- Current sampling strategy:
  - Begin sampling at the start of the season and encourage participants to continue, sampling through the end of their harvest season,
  - Sample as many fish as you can from each reporting area,
  - Sample from as many fishers as you can from each reporting area.

RECOMMENDATIONS

- Record and report the number of different fishers being sampled by participants collecting ASL data from Chinook salmon in the Kuskokwim River subsistence harvest. This is in contrast to knowing only the number of participants collecting ASL data in 2004.
- Prepare a sampling design for ASL collection to include gear type categories, time strata and minimum sample size per stratum for analysis.
- Assess the effectiveness of the subsistence fishing schedule by continuing the multi-year subsistence sampling program and expand to again sample upper and middle river harvests to allow for comparison of ASL data collections between reporting areas and escapement projects for years when the subsistence fishing schedule is used and years when the schedule is not used.
- Analyze data from the post-season subsistence survey that documents the degree to which large mesh gillnets are used. Survey results currently identifies “drift gillnet” and “set gillnet” categories. These categories could each be divided into “…gillnets with large mesh (8 inch or greater)”, “… gillnets with small mesh (6 inch or smaller), and “…gillnets with intermediate mesh size” used for Chinook salmon.
- Increase return of catch calendars and from them estimate harvest through time in order to combine with ASL samples collected from weekly subsistence fishing periods.

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TABLES AND FIGURES

Table 1.–Gear types reported used for subsistence fishing in the Kuskokwim Area, 2004.

	Number of Households Reporting Gear Types Used						
Reporting Area	**Set Gillnet**	**Drift Gillnet**	**Fish Wheel**	**Rod & Reel**	**Seine**	**Spear**	**Total**
Lower Kuskokwim River	132	723	0	159	1	0	1,015
	13%	71%	0%	16%	0%	0%	
Middle Kuskokwim River	30	99	0	73	0	1	203
	15%	49%	0%	36%	0%	0%	
Upper Kuskokwim River	54	40	1	61	0	0	156
	35%	26%	1%	39%	0%	0%	
Drainage Total	216	862	1	293	1	1	1,374
	16%	63%	0%	21%	0%	0%	

Source: T. Krauthoefer, Division of Subsistence, ADF&G, Bethel; personal communication.

Table 2.–Sample distribution by gear type and location in the 2004 Kuskokwim River Chinook salmon subsistence harvest age, sex, and length (ASL) sampling program.

		Lower Kuskokwim River				
Gear Type	**Mesh Size**	**Tuntutuliak**	**Bethel**	**Kwethluk**	**Akiachak**	**Total**
Gillnets	**≥ 8 Inches**					
	8¼ inch mesh	234	227			
	8⅛ inch mesh		200			
	8 inch mesh	251	1,109	30	40	
	Subtotal	485	1,536	30	40	2,091
	Percent	21%	67%	1%	2%	91%
	> 6 and < 8 Inches					
	7½ inch mesh		20			
	6½ inch mesh		100			
	Subtotal	0	120	0	0	120
	Percent	0%	5%	0%	0%	5%
	≤ 6 Inches					
	6 inch mesh		19			
	5½ inch mesh		40		20	
	Subtotal	0	59	0	20	79
	Percent	0%	3%	0%	1%	4%
Subtotal [a]		485	1,715	30	60	2,290
Percent		21%	75%	1%	3%	100%
Number of Participant Samplers		4	15	1	1	21

[a] Sample size includes unaged Chinook salmon samples.

Table 3.–Age and sex composition of Chinook salmon samples from the lower Kuskokwim River subsistence fishery, 2004.

			Age Class													
Sample	Sample		1.1		1.2		1.3		2.2		1.4		1.5		Total	
Date	Size	Sex	N	%	N	%	N	%	N	%	N	%	N	%	N	%
5/31–6/28	43	M	0	0.0	21	48.8	15	34.9	0	0.0	4	9.3	0	0.0	40	93.0
≤ 6 inch mesh		F	0	0.0	0	0.0	0	0.0	0	0.0	3	7.0	0	0.0	3	7.0
		Total	0	0.0	21	48.8	15	34.9	0	0.0	7	16.3	0	0.0	43	100.0
6/4–6/12	99	M	0	0.0	48	48.5	30	30.3	0	0.0	9	9.1	0	0.0	87	87.9
6 ½–7 ⅞ inch mesh		F	0	0.0	0	0.0	1	1.0	0	0.0	11	11.1	0	0.0	12	12.1
		Total	0	0.0	48	48.5	31	31.3	0	0.0	20	20.2	0	0.0	99	100.0
5/30–6/5	167	M	0	0.0	11	6.6	46	27.5	0	0.0	50	29.9	6	3.6	113	67.7
≥ 8 inch mesh		F	0	0.0	0	0.0	5	3.0	0	0.0	37	22.2	12	7.2	54	32.3
		Subtotal	0	0.0	11	6.6	51	30.5	0	0.0	87	52.1	18	10.8	167	100.0
6/9–6/12	856	M	2	0.2	87	10.2	249	29.1	2	0.3	200	23.4	10	1.2	550	64.3
≥ 8 inch mesh		F	0	0.0	2	0.2	50	5.8	1	0.1	243	28.4	10	1.1	306	35.7
		Subtotal	2	0.2	89	10.4	299	34.9	3	0.4	443	51.8	20	2.3	856	100.0
6/16–6/19	558	M	1	0.2	82	14.7	188	33.7	2	0.3	99	17.7	4	0.7	376	67.4
≥ 8 inch mesh		F	0	0.0	0	0.0	30	5.4	1	0.2	146	26.2	5	0.9	182	32.6
		Subtotal	1	0.2	82	14.7	218	39.1	3	0.5	245	43.9	9	1.6	558	100.0
6/20–7/19	256	M	0	0.0	25	9.8	89	34.8	0	0.0	54	21.1	1	0.4	169	66.0
≥ 8 inch mesh		F	0	0.0	0	0.0	19	7.4	0	0.0	64	25.0	4	1.6	87	34.0
		Subtotal	0	0.0	25	9.8	108	42.2	0	0.0	118	46.1	5	2.0	256	100.0
5/30–7/19	1,837	M	3	0.2	205	11.2	572	31.1	4	0.2	403	21.9	21	1.1	1,208	65.8
≥ 8 inch mesh		F	0	0.0	2	0.1	104	5.7	2	0.1	490	26.7	31	1.7	629	34.2
All Dates Combined		Total	3	0.2	207	11.3	676	36.8	6	0.3	893	48.6	52	2.8	1,837	100.0
5/30–7/19	1,979	M	3	0.2	274	13.8	617	31.2	4	0.2	416	21.0	21	1.1	1,335	67.5
All Gear Types		F	0	0.0	2	0.1	105	5.3	2	0.1	504	25.5	31	1.6	644	32.5
		Total	3	0.2	276	13.9	722	36.5	6	0.3	920	46.5	52	2.6	1,979	100.0

Table 4.–Mean length of Chinook salmon samples from the lower Kuskokwim River subsistence fishery, 2004.

			Age Class					
Sample Date	**Sex**		**1.1**	**1.2**	**1.3**	**2.2**	**1.4**	**1.5**
5/31–6/28	M	Mean Length (mm)		591	688		787	
≤ 6 inch mesh		Range		505-750	585-775		660-917	
		Sample Size	0	21	15	0	4	0
	F	Mean Length (mm)					865	
		Range					805-905	
		Sample Size	0	0	0	0	3	0
6/4–6/12	M	Mean Length (mm)		599	677		803	
6 ½–7 ⅞ inch mesh		Range		545-670	580-850		585-1000	
		Sample Size	0	48	30	0	9	0
	F	Mean Length (mm)			805		801	
		Range			805-805		667-915	
		Sample Size	0	0	1	0	11	0
5/30–6/5	M	Mean Length (mm)		639	718		816	802
≥ 8 inch mesh		Range		565-690	610-890		690-980	680-920
		Sample Size	0	11	46	0	50	6
	F	Mean Length (mm)			741		870	888
		Range			630-810		750-1000	830-950
		Sample Size	0	0	5	0	37	12
6/9–6/12	M	Mean Length (mm)	419	596	724	631	809	869
≥ 8 inch mesh		Range	400-438	440-810	510-890	611-650	530-1030	790-1055
		Sample Size	2	87	249	2	200	10
	F	Mean Length (mm)		655	773	570	853	855
		Range		649-660	600-894	570-570	700-1015	776-920
		Sample Size	0	2	50	1	243	10
6/16–6/19	M	Mean Length (mm)	430	589	721	695	803	949
≥ 8 inch mesh		Range	430-430	500-690	580-830	680-710	400-980	815-1050
		Sample Size	1	82	188	2	99	4
	F	Mean Length (mm)			758	690	855	888
		Range			650-850	690-690	735-980	860-940
		Sample Size	0	0	30	1	146	5

-continued-

Table 4.–Page 2 of 2.

Sample Date	Sex		Age Class 1.1	1.2	1.3	2.2	1.4	1.5
6/20–7/19	M	Mean Length (mm)		604	734		818	870
≥ 8 inch mesh		Range		480-706	604-835		631-1,000	870-870
		Sample Size	0	25	89	0	54	1
	F	Mean Length (mm)			790		848	842
		Range			680-865		708-988	758-900
		Sample Size	0	0	19	0	64	4
5/30–7/19	M	Mean Length (mm)	423	597	734	663	809	865
≥ 8 inch mesh		Range	400-438	440-810	510-890	611-710	400-1,030	680-1,055
All Dates Combined		Sample Size	3	205	572	4	403	21
	F	Mean Length (mm)		655	770	630	854	871
		Range		649-660	600-894	570-690	700-1,015	758-950
		Sample Size	0	2	104	2	490	31
5/30–7/19	M	Mean Length (mm)	423	596	700	663	800	865
All Gear Types		Range	400-438	440-810	510-890	611-710	400-1,030	680-1,055
		Sample Size	3	274	617	4	416	21
	F	Mean Length (mm)		655	788	630	840	871
		Range		649-660	600-894	570-690	700-1,015	758-950
		Sample Size	0	2	105	2	504	31

Table 5.–Estimated age and sex composition of Chinook salmon from the Kuskokwim River subsistence fishery by area, 2004.

		Age Class (Major Age Classes only)													
		1.2		1.3		2.2		1.4		1.5		1.6		Total	
Reporting Area	**Sex**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Lower Kuskokwim River	M	9,461	13.8	21,390	31.2	137	0.2	14,397	21.0	754	1.1	0	0.0	46,277	67.5
	F	69	0.1	3,634	5.3	69	0.1	17,483	25.5	754	1.1	0	0.0	22,282	32.5
	Total	9,530	13.9	25,024	36.5	206	0.3	31,880	46.5	1,783	2.6	0	0.0	68,559	100.0
Middle Kuskokwim River	Total													8,007	100.0
Upper Kuskokwim River	Total													3,499	100.0
Total Kuskokwim River	M	11,049	13.8	24,980	31.2	160	0.2	16,814	21.0	881	1.1	0	0.0	54,044	67.5
	F	80	0.1	4,243	5.3	80	0.1	20,417	25.5	881	1.1	0	0.0	26,021	32.5
	Total	11,129	13.9	29,224	36.5	240	0.3	37,230	46.5	2,082	2.6	0	0.0	80,065	100.0

Note: Subsistence harvest numbers (N) correspond to draft data complied by ADF&G Division of Subsistence.

Table 6.–Estimated age and sex composition of Chinook salmon from the Kuskokwim River subsistence fishery, 2004.

		Age Class													
		1.2		1.3		2.2		1.4		1.5		1.6		Total [a]	
Year	Sex	N	%	N	%	N	%	N	%	N	%	N	%	N	%
2001 [b]	M	3,239	4.4	18,623	25.3	0	0.0	24,070	32.7	1,399	1.9	0	0.0	47,552	64.6
Kuskokwim River	F	147	0.2	3,386	4.6	0	0.0	20,537	27.9	1,914	2.6	0	0.0	26,058	35.4
Total	Total	3,386	4.6	22,009	29.9	0	0.0	44,608	60.6	3,312	4.5	0	0.0	73,610	100.0
2002 [b]	M	4,031	6.0	16,977	25.4	12	0.0	17,040	25.5	1,575	2.4	0	0.0	39,635	59.3
Kuskokwim River	F	1,193	1.8	5,266	7.9	0	0.0	18,863	28.2	1,808	2.7	42	0.1	27,190	40.7
Total	Total	5,224	7.8	22,243	33.3	12	0.0	35,902	53.7	3,383	5.1	42	0.1	66,807	100.0
2003 [b]	M	4,338	6.4	23,726	35.0	0	0.0	12,541	18.5	1,695	2.5	0	0.0	42,503	62.7
Kuskokwim River	F	203	0.3	6,236	9.2	0	0.0	15,998	23.6	2,847	4.2	0	0.0	25,285	37.3
Total	Total	4,542	6.7	29,962	44.2	0	0.0	28,539	42.1	4,542	6.7	0	0.0	67,788	100.0
2004	M	11,049	13.8	24,980	31.2	160	0.2	16,814	21.0	881	1.1	0	0.0	54,044	67.5
Kuskokwim River	F	80	0.1	4,243	5.3	80	0.1	20,417	25.5	881	1.1	0	0.0	26,021	32.5
Total	Total	11,129	13.9	29,224	36.5	240	0.3	37,230	46.5	2,082	2.6	0	0.0	80,065	100.0

Note: Applied percentages for each reporting area are from samples collected in each reporting area.

[a] Subsistence harvest numbers correspond to draft data complied by ADF&G Division of Subsistence.

[b] The number of fish in the "Kuskokwim River Total" is the sum of the lower, middle and upper reporting areas. Percentages are derived from the sum across reporting areas.

Table 7.–Estimated age, sex, and length (ASL) composition of the Kuskokwim River Chinook salmon escapement, commercial harvest, and subsistence harvest, 2004.

	Age-Sex Category[b]						
Information Source[a]	**Male 1.2**	**Male 1.3**	**Female 1.3**	**Male 1.4**	**Female 1.4**	**Male 1.5**	**Female 1.5**
Tatlawiksuk Weir	24.9	31.9	8.7	10.6	22.3	0.4	1.2
Kogrukluk Weir	44.1	33.6	2.6	6.0	12.5	0.0	0.6
George Weir	25.2	17.4	3.8	17.8	31.8	1.2	1.5
Kwethluk Weir	56.1	21.2	1.5	5.2	14.7	0.1	0.5
Tuluksak Weir	22.1	34.6	7.8	6.5	24.7	0.4	0.6
Escapement Average	34.5	27.7	4.9	9.2	21.2	0.5	0.9
Commercial W-1	57.8	23.8	1.6	5.7	8.9	0.0	0.6
Subsistence Fishery	13.8	31.2	5.3	21.0	25.5	1.1	1.1

	Average Length by Age (mm)						
Tatlawiksuk Weir	592	704	728	819	823	0	0
Kogrukluk Weir	594	688	772	790	857	0	865
George Weir	600	713	793	853	843	819	912
Kwethluk Weir	589	691	813	807	871	685	891
Tuluksak Weir	594	706	774	810	867	1160	875
Escapement Average	594	700	776	816	852	888	886
Commercial W-1	577	671	776	809	845	0	913
Subsistence Fishery	596	700	788	800	840	865	871

	Percent Females	**SE**	**Sample Size**
Tatlawiksuk Weir	32.6	2.7	301
Kogrukluk Weir	16.4	1.4	731
George Weir	37.7	3.0	269
Kwethluk Weir	16.7	1.1	1,151
Tuluksak Weir	35.6	3.0	255
Escapement Average	27.8	0.9	2,707
Commercial W-1	10.5	1.6	348
Subsistence Fishery	32.5	1.1	1,979

[a] Samples from the Takotna weir were omitted. Too few samples were collected (69).

[b] Rare sex and age class combinations were not included (female age 1.2 and age 2.2).

Figure 1.–Kuskokwim Management Area (W) and commercial fishing districts in the Kuskokwim River (W-1 and W-2).

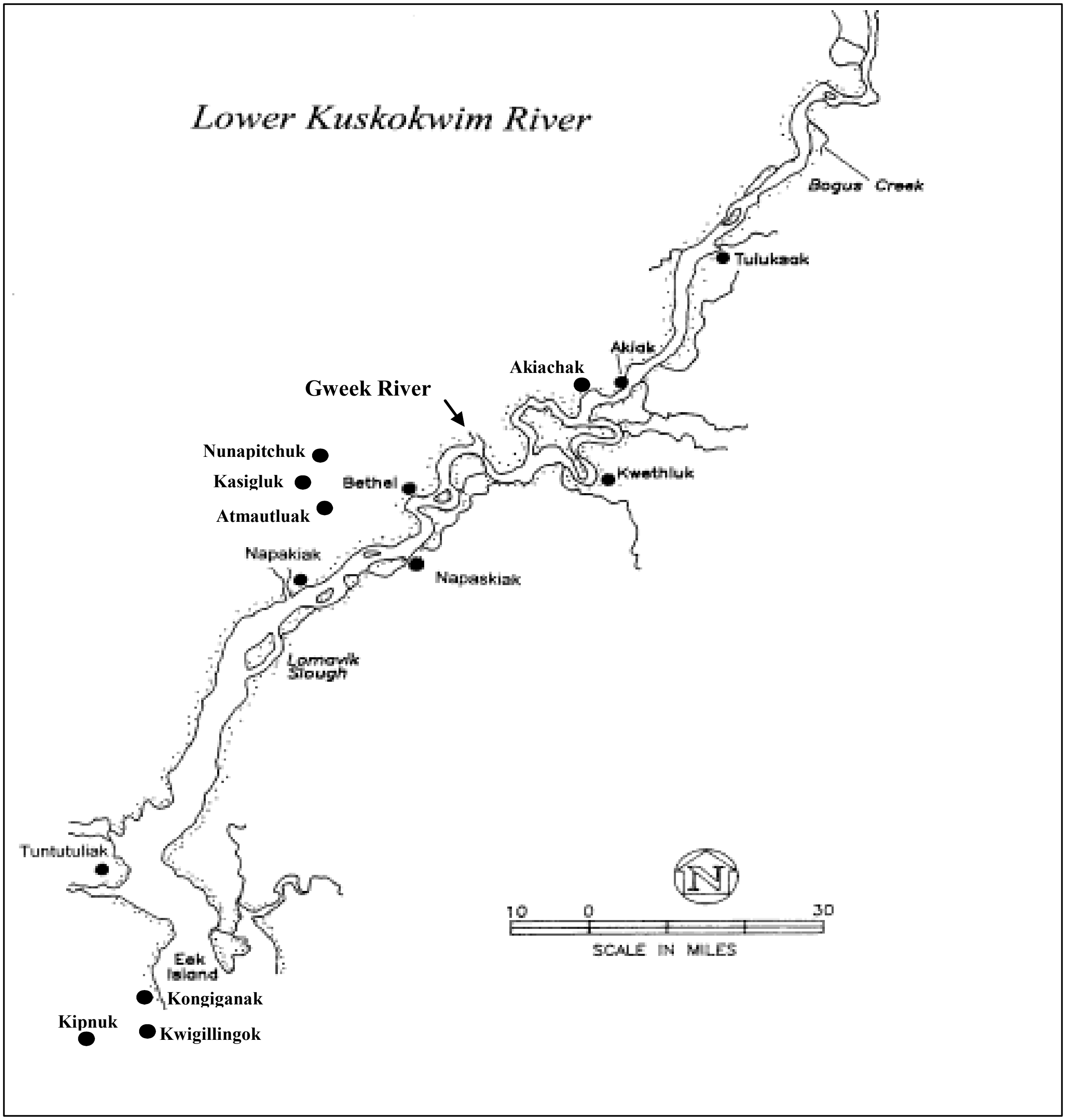
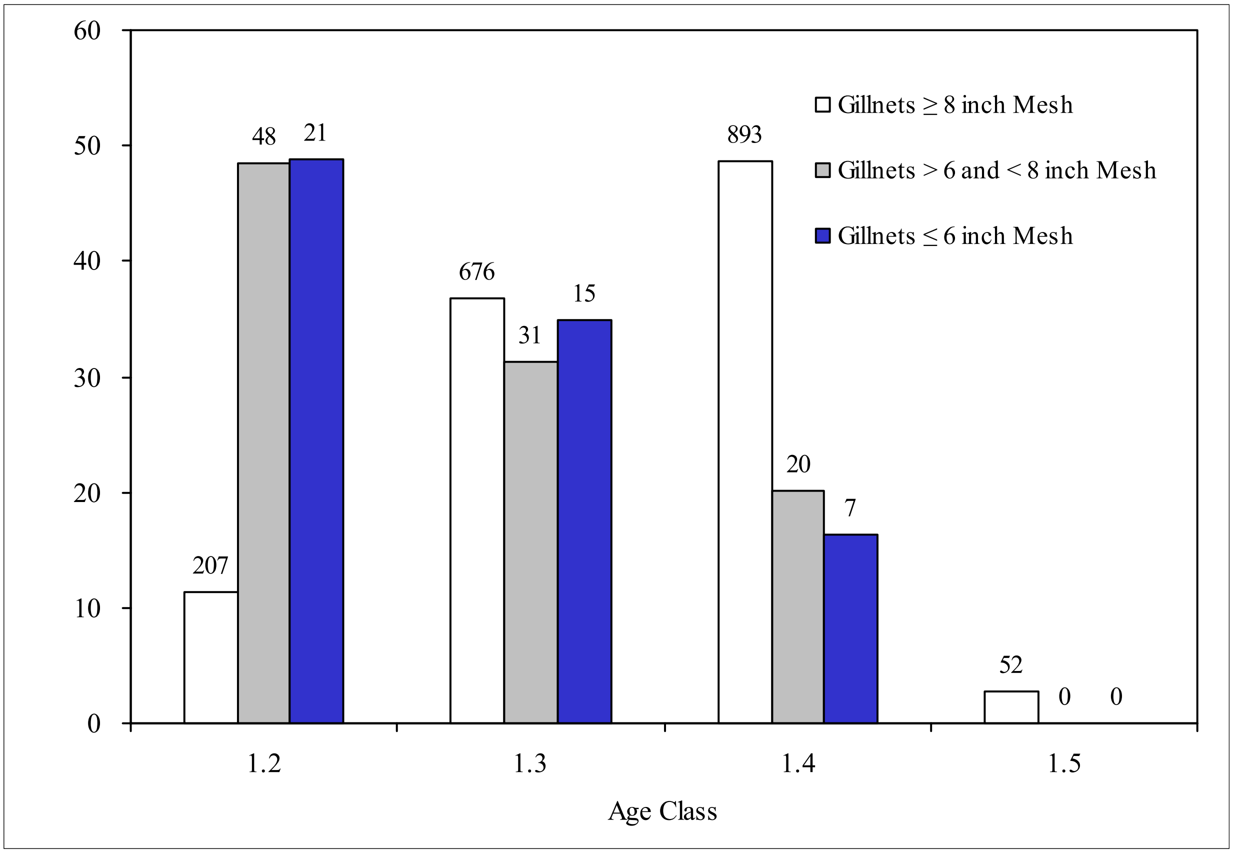


Figure 2.–The lower Kuskokwim River reporting area, with notation of village locations.



Note: The number on the top of each bar is the sample size.

Figure 3.–Age class composition of Chinook salmon harvest by gear type in the lower Kuskokwim River subsistence fishery, 2004.

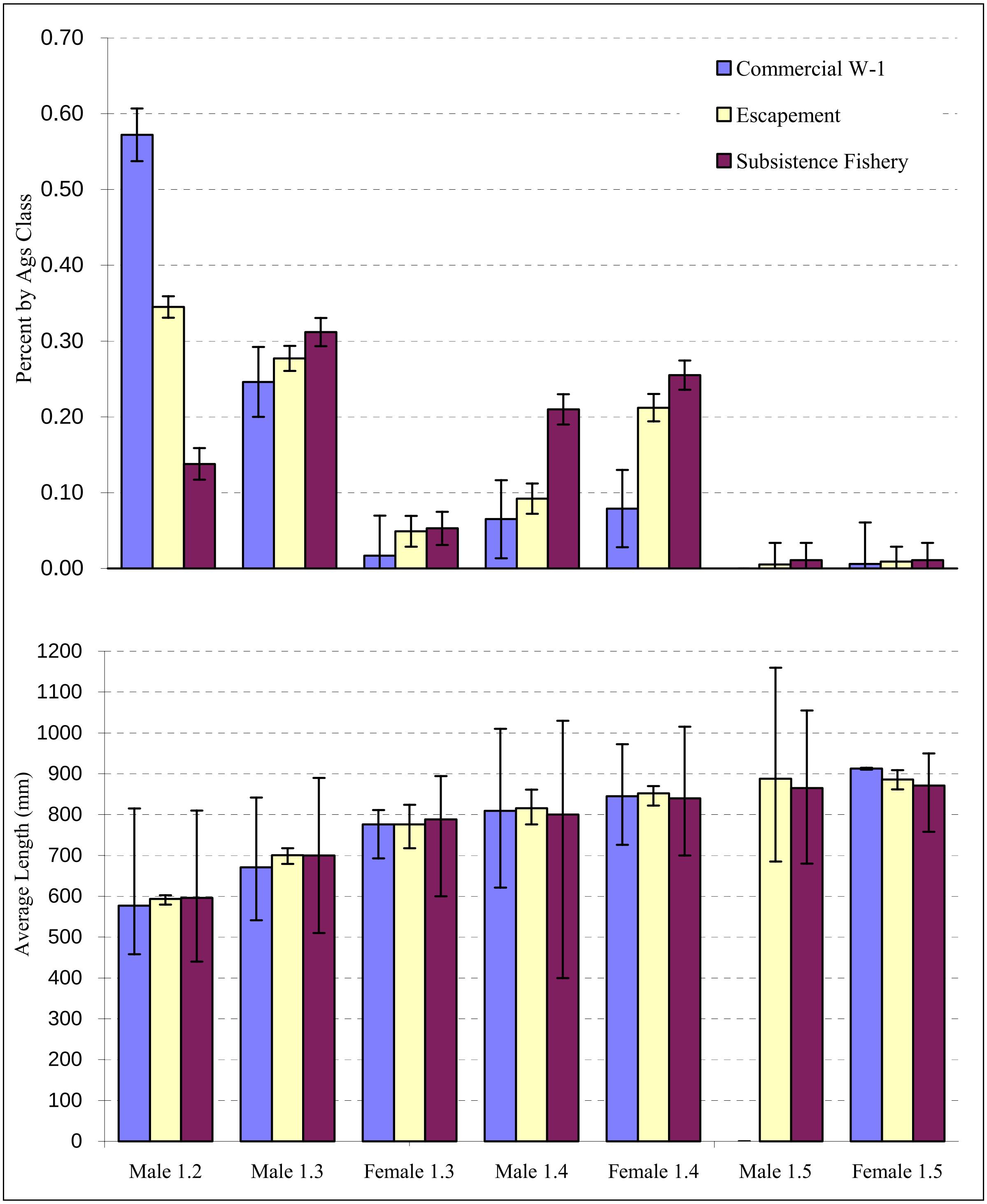


Figure 4.–Estimated age and sex composition of the 2004 Kuskokwim River Chinook salmon subsistence harvest, commercial harvest, and escapement with ±SE and mean length with data ranges.

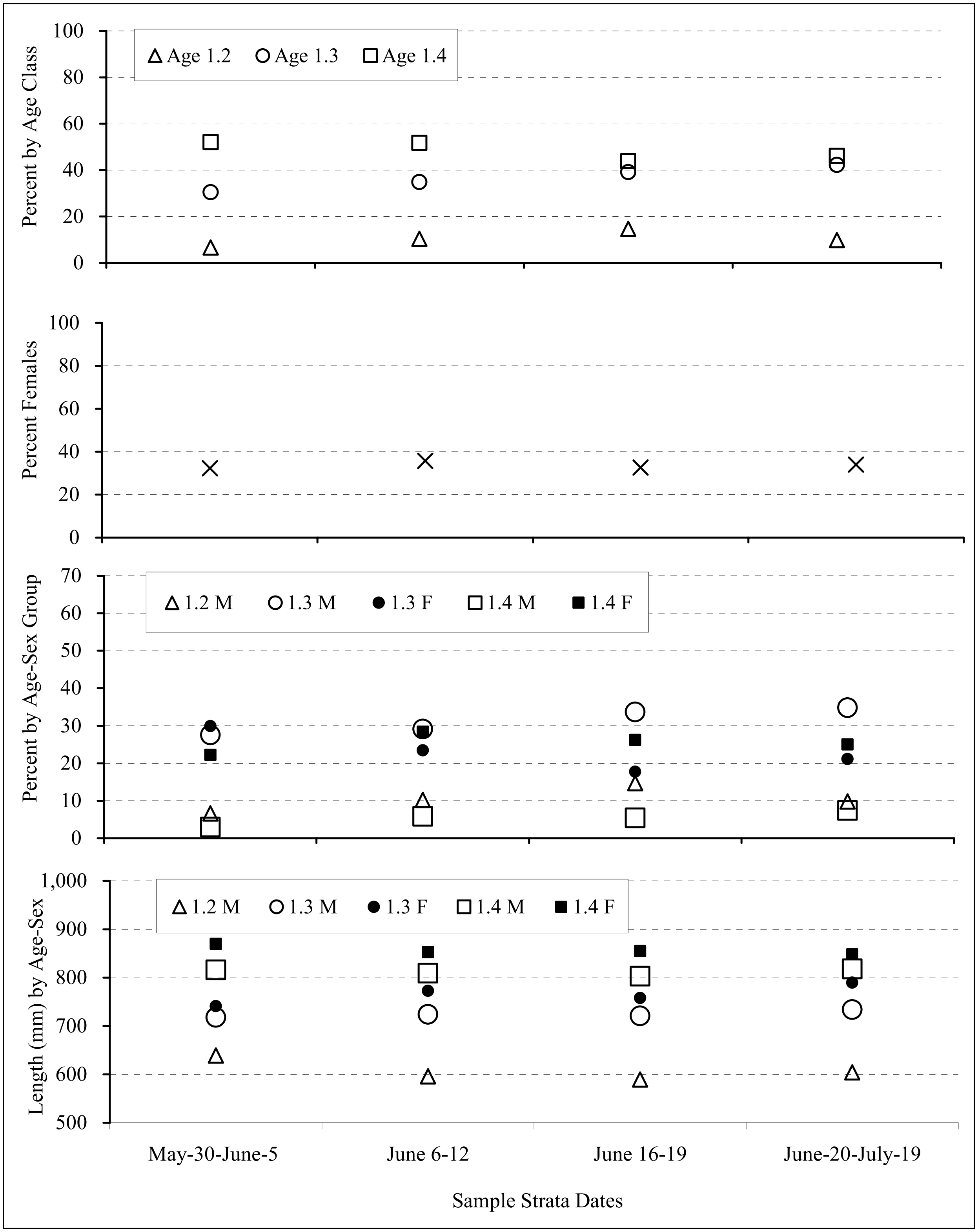


Figure 5.–Temporally stratified age, sex, and length (ASL) composition of Chinook salmon harvested in the lower Kuskokwim River subsistence fishery with gillnets of ≥ 8-inch mesh size, 2004.

APPENDIX A. AGE, SEX, AND LENGTH SAMPLING

Appendix A1.–Instruction sheet for Chinook salmon age, sex, and length (ASL) sampling, 2004.

SUBSISTENCE KING SALMON DATA FORM

Name: ______________________ Scale Card Number: ______________

Address: ____

Sample Date: __________ (month/ day/ year) SSN: ______________

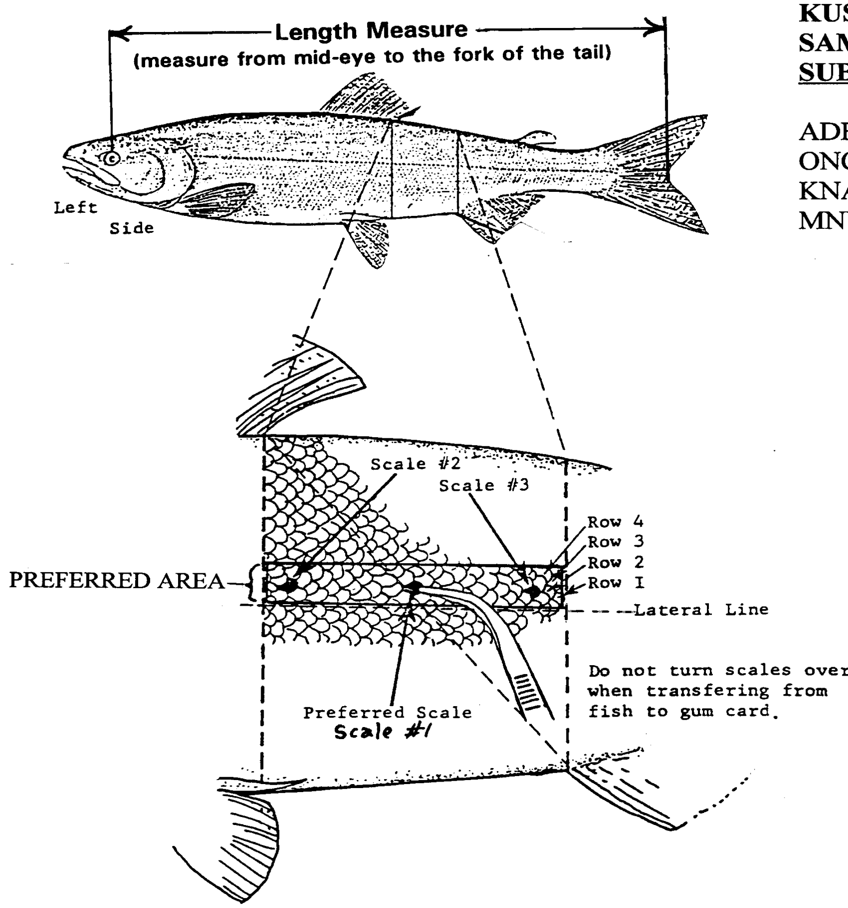
Location: ______________________ (examples: Kuskokwim River near Bethel, Kuskokwim River near Akiak)

Gear Type: Drift Gillnet Set Gillnet Rod & Reel Fishwheel

Mesh Size: ________ Did you cut every fish to look for eggs? Yes or No

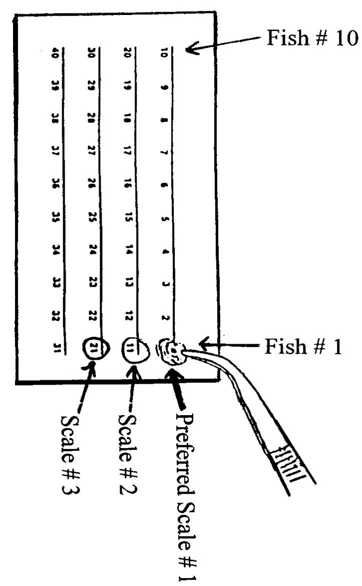
Fish Number	Sex (M or F)	Length (mm)	Comments
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Appendix A2.–Instruction sheet for Kuskokwim River subsistence fishery Chinook salmon age, sex, and length (ASL) sampling, 2004.



KUSKOKWIM RIVER
SAMPLING PROGRAM FOR
SUBSISTENCE KING SALMON

ADF&G (Bethel) 543-2433
ONC (Bethel) 543-2608
KNA (Aniak) 675-4384
MNVC (McGrath) 524-3023



Age-Sex-Length Sampling Instructions

1) Position king salmon left side up.
2) Take preferred scale #1 located two rows above the lateral line and intersecting a diagonal line from the back of the dorsal fin to the front of the anal fin.
3) Clean scale by removing slime.
4) Place scale directly over number on gum card. Be cafeful to keep scale right side up and mount scale in same orientation.
5) Repeat above steps for scales #2 and #3 (see picture).
6) Measure length (mm) from mid-eye to fork of tail.
7) Cut fish belly and determine sex.

Payment requires the following information for each king salmon:

1) Three readable scales from each fish.
2) Sex of each fish.
3) Length of each fish.
4) Gear type and mesh size.
5) Date of capture.
6) Location of capture.
7) Your name on data form and scale card.

Appendix A3.–A summary of the 2004 sampling program distributed to participants and interested groups in April 2005.

Age-Sex-Length Sampling from Subsistence Harvested King Salmon in 2004.

Subsistence fishers in the Kuskokwim River collected information from their king salmon harvests to help biologists better understand the needs of subsistence users. The following information is a summary of those findings:

(1) Twenty-one samplers from local communities participated in the Kuskokwim River age-sex-length sampling program in 2004.
(2) A total of 2,290 king salmon were sampled from Kuskokwim River harvests near Tuntutuliak, Bethel, Kwethluk and Akiachak.
(3) Samples were collected from a variety of gear types (Figure 1):
 (a) 7 drift gillnet mesh sizes (5 1/2, 6, 6 1/2, 7 1/2, 8, 8 1/8, and 8 1/4 inches).
 (b) 3 set gillnet mesh sizes (5 1/2, 7 1/2, and 8 inches),
 (c) 91% were from gillnets with mesh size of 8 inches or larger.

(4) Sex composition by mesh size was (Figure 2):
 (a) 7 % female for less than or equal to 6 inch mesh,
 (b) 12.1 % female for 6 1/2 - 7 1/2 inch mesh,
 (c) and 34.2% female for greater than or equal to 8 inch mesh.

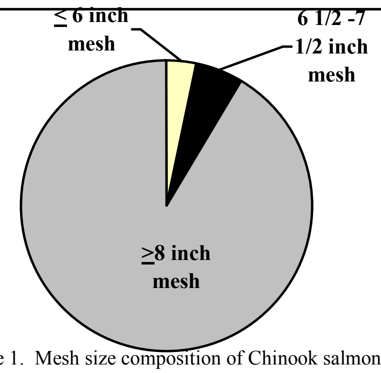


Figure 1. Mesh size composition of Chinook salmon samples collected in the Kuskokwim River subsistence fishery.

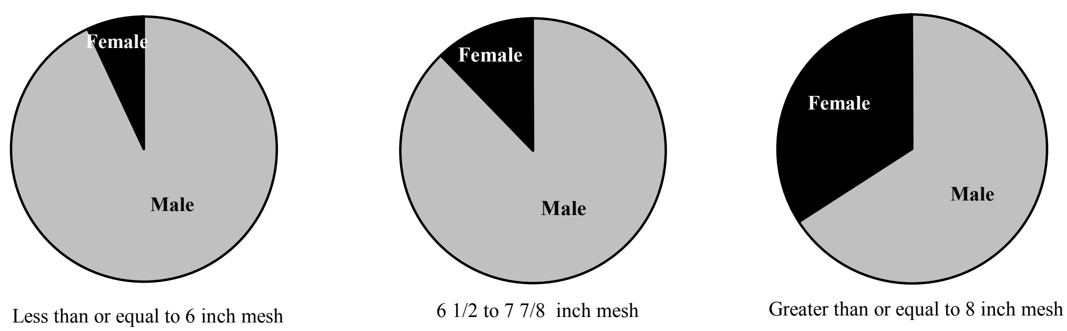


Figure 2. Sex composition, by mesh size, of Chinook salmon sampled in the Kuskokwim River subsistence fishery.

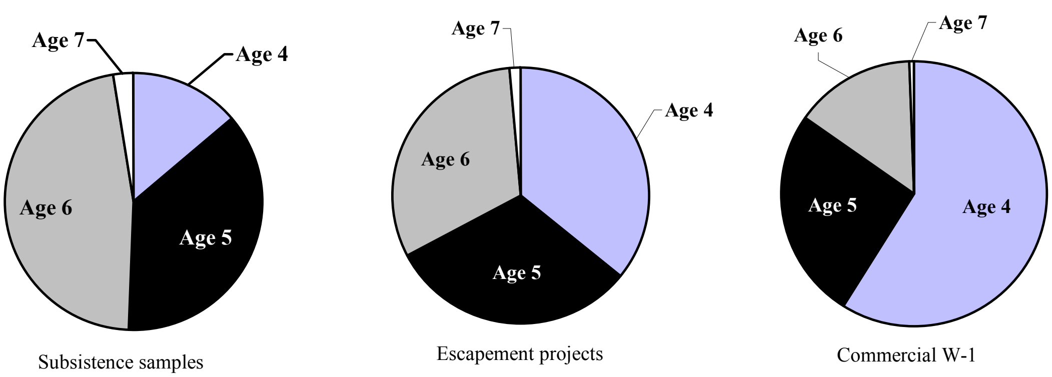


Figure 3. Age composition from Chinook salmon in the subsistence fishery, escapement projects, and commercial W-1.

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These grants were administered by, ADF&G, and Orutsararmuit Native Council.

APPENDIX B. CHINOOK SALMON SUBSISTENCE HARVEST

Appendix B1.–Kuskokwim River Chinook salmon subsistence harvests, 2001 through 2004.

	Year			
Community	**2001**	**2002**	**2003**	**2004**
Lower Kuskokwim River Reporting Area				
Kipnuk	1	1	0	49
Kwigillingok	0	0	0	345
Kongiganak	1,454	808	1,386	1,478
Tuntutuliak	2,993	3,632	3,095	3,402
Eek	1,728	2,432	2,364	2,636
Kasigluk	588	381	356	1,526
Nunapitchuk	3,250	3,883	3,763	4,104
Atmautluak	740	1,282	1,396	1,701
Napakiak	2,290	1,931	2,105	2,060
Napaskiak	4,662	3,856	5,012	3,220
Oscarville	1,753	953	1,073	998
Bethel	27,209	19,305	21,475	27,504
Kwethluk	6,127	6,429	4,938	6,119
Akiachak	6,445	6,860	5,346	6,647
Akiak	3,369	3,340	3,896	3,653
Tuluksak	2,451	2,364	3,678	3,117
Lower Kuskokwim Subtotal	65,060	57,457	59,883	68,559
Middle Kuskokwim River Reporting Area				
Lower Kalskag	2,181	1,210	2,016	1,918
Upper Kalskag	1,014	1,420	1,128	2,442
Aniak	2,524	2,994	2,077	2,606
Chuathbaluk	627	663	399	1,041
Middle Kuskokwim Subtotal	6,346	6,287	5,620	8,007
Upper Kuskokwim River Reporting Area				
Crooked Creek	508	790	831	1,003
Red Devil	175	248	72	165
Sleetmute	473	516	685	618
Stony River	139	293	111	621
Lime Village	262	0	65	66
McGrath	360	700	506	500
Takotna	5	9	0	16
Nikolai	282	507	15	510
Telida	0	0	0	0
Upper Kuskokwim Subtotal	2,204	3,063	2,285	3,499
Kuskokwim River Total	73,610	66,807	67,788	80,065

Note: These data are considered draft until submitted for the 2004 Kuskokwim Annual Management Report.

Source: T. Krauthoefer, Division of Subsistence, ADF&G, Bethel; personal communication.